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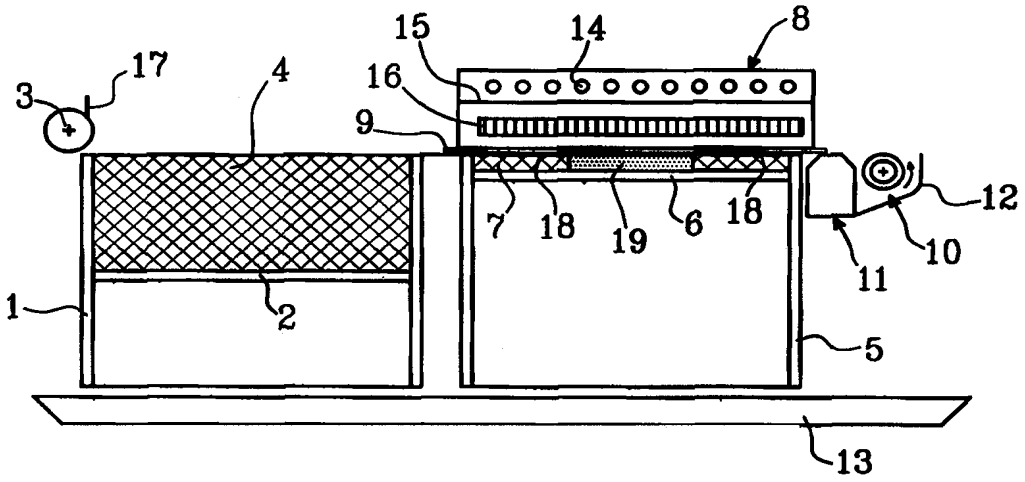
(54) Title: METHOD AND DEVICE FOR MANUFACTURING THREE–DIMENSIONAL BODIES



(57) Abstract

A method for producing three–dimensional bodies of a large number of mutually connected layers of a particle–shaped material such as a powder, and where the information of the appearance of each layer is achieved from a computer's CAD–unit or similar. An essentially even particle layer (7) of building material is applied on a support base (6) and on a masking device (9) is arranged a masking pattern in accordance with the information from the CAD–unit, which masking device is led over said particle layer and close to it. A radiation producer (8) is arranged or is led over the masking device (9), whereby the particles which are not covered by the masking pattern are exposed for radiation and thereby are attached to each other. The masking pattern is removed from the masking device and new sequences in accordance with the above are carried through until the three–dimensional body (19) is produced.

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METHOD AND DEVICE FOR MANUFACTURING THREEDIMENSION BODIES

The present invention concerns a method and a device for manufacturing threedimensional bodies of a great number of mutually connected layers of a particle shaped material, such as a powder, and where the information of the appearance of each layer is achieved from a computer's CAD-unit or similar.

BACKGROUND AND PROBLEM

Manufacturing of prototypes from originals in form of separate CAD-drawings,where the information from each layer is used for stiffening or melting together material to a threedimensional body, is earlier known. US 4,575,330 describes the use of a UV-laser beam for hardening (stiffening) the surface layer in a reservoir with liquid plastic (photopolymer). In order to be able to build details with thin walls and with high precision the focus point (diameter) of the laser is minimized to fractions of 1 millimeter. The laser beam must illuminate all surfaces which shall become solid. That makes that it takes long time to produce a detail.

In EP-A2 470 705 is described a threedimensional modelling, where the speed has been increased by illuminating the whole surface at one time with a large UV-lamp. The UV-light is shielded with toner from a laser printer on a glass plate. In order to manage details with overhang a support stucture is built with the aid of wax, which solidify.

The drawbacks with reactive liquid plastics are that they are dangerous for the personel and for the environment and that variations of different qualities are limited.

In order to avoid this and the use of a support structure a plastic or wax powder is used , where the unsintered powder bakes in the proceeding layers and in this way supports possible "overhang", such as when a hat on a mushrom is made. These machines, e.g. from the german firm EOS GmbH and the US-firm DTM Inc. use a controlable laser beam to selectively meltening the powder. In order to increase the speed one has on these machines heated the powder reservoir to a temperature just below the meltingpoint of the powder and let the laser beam increase the temperature the degrees that are neccesary for melt/sinter together the powder. Despite of that it will take 10-20 hours to manufacture a prototype detail of normal size. Machines based on laser or UV technique are very expensive to buy. The costs are in the order of 3-6 million SEK.

THE PURPOSE WITH THE INVENTION AND THE SOLUTION OF THE PROBLEM

The purpose with the present invention is to eliminate the above mentioned drawbacks and to achieve:

- threedimensional bodies, also such with thin walls and with high precision
- articles with overhang without the aid of support structures
- a method which is not dangerous for the personel and for the enviromnent
- large qualitative possibilities of variations
- a simple, inexpensive and reliable machine equipement
- fast manufacturing of threedimensional bodies

These objects have been achieved by the steps that an essentially even particle layer is applied on a support surface, that on a masking device is arranged a masking pattern in accordance with the information from the CAD-unit, which masking device is led over said particle layer and close to it, that a radiation producer is arranged or is led over the masking device, whereby the particles which are not covered by the masking pattern are exposed for radiation and thereby are attached to each other, that the masking pattern is removed from the masking device and that new sequences in accordance with the above are carried through until the threedimensional body is produced.

DESCRIPTION OF THE DRAWINGS

The invention will in the following in more detail be described with reference to the enclosed drawings which show by way of example embodiments of the invention. Figures 1-6 show

in sequential step the function of a device, shown in cross-section, for manufacturing of threedimensional bodies in accordance with the invention.

DESCRIPTION OF AN EMBODIMENT

The inventive idea is to use one for a heat medium, such as IR-radiation, permeable means, on which is applied a temporary, negative masking, which is controlled by a computer and which shields and thereby prevents penetration of the radiation, while free regions permit penetration of radiation to an underlying surface. Which consists of a particle shaped material, e.g. a meltable or sinterable powder. The masking is done with a masking device 9, e.g. a transparent silica plate 9a, on which a developer 11, for instance in the form of a write head, has deposit a masking layer. The masking device is so arranged that either the plate 9a and/or the write head is movable in a longitudinal direction. Conventional toner powder which is used in writers are not suitable as it comprises a thermoplastic adhesive, which would permanently melt and adhere the toner on the plate. An example of an infra-red masking powder 4, which does not melt and adhere, is aluminiumoxide, which has a high meltingpoint and degree of reflexion.

To make it possible to apply the masking powder on the silica plate 9a this can be covered with an electrically conductive but transparent layer, for instance such as is used for shielding of viewing screens and for so called smart windows. An other way is to place a separate conduit behind the silica palate opposite the write head. It is important that the IR-radiation hits the silica plate as parallell as possible, so that the beams do not shine below the masking and cause a bad accuracy. This can be arranged with beams directing means 16, such as a collimator, applied between IR-lamps 14 and the silica plate 9a and which makes the IR-beams parallell. The construction's movements can mechanically be coordinated, for instance can the same movement which transfer the masking device 9 be used to spread and rake out a new powder layer.

The wavelength of the IR-radiation shall be adapted to the emission maximum of the plastic powder, i.e. so that most of the energy is absorbed in the most upper powder layer, which gives a high efficiency, thin layers and short heating time to melt/sinter the powder material.The high absorption admit that one can supply high radiation energy, concentrated to the surface of the powder, which is a condition for fast production of thin layers, before heat spreading through condution and internal transmission radiation destroy the accuracy of the melted layers. Another way or in combination with the above is to increase absorption by chosing a plastic powder which has a large proportion of polar OH-groups or double bonds in the molecular chaines. If one choses IR-radiation in the medium-wave range and with an emission maximum at 860 nanometer the vibration frequency for these atomic bonds coincides with the IR-radiation and a heavy heat release will occur. The powder material can consist of a thermoplastic material, such as nylon,comprising one or several different pigment, e.g. carbon black or a filling agent, which either is drymixed or mixed during manufacturing before pulverization. The powder can also be provided with additives which increase certain properties, such as reinforcement and be mixed with powders with different melt intervals in order to minimize shrinking when stiffening. The powder can have different particle sizes for increasing the dry volyme weight (density) of the powder. Hightemperature powder, such as ceramics, can be used to increase the strength and possible after sintering in an oven, where the plastic adhesive can be combusted and the hightemperature material can be sintered. The powder material can also have thermohardening properties, i.e. so that the powder after sintering/melting makes a heat reactive hardener to cross-bind the chains of the plastic molecules. An example of such a plastic can be epoxide with amine hardener. Also an UV-hardener can

be added to the powder in order to, at a later occasion, expose the threedimensional body for afterhardening by irradiation in lamp- or sunlight.

DESCRIPTION OF THE FUNCTION

Figure 1 shows a position shortly after the start position, with a filled powder reservoir 1, one in that up and down moveable base 2 and a number of already laid out powder layer 7, which has been transferred to a building reservoir 5, which is provided with a likewise up and down moveable base 6. A masking device 9 and a radiation producer 8 is in parking position.

In figure 2 the base 2 in the powder reservoir 1 has been lifted one step and the base 6 in the building reservoir has been lowered corresponding to the thickness of a powderlayer (e.g. 0, 1 mm). A spreader device, e.g. in the form of a wiper roll 3, has been caused to rotate and at the same time it is moved across the powder reservoir 1 while scraping a powder layer. This is transported to a builing reservoir 5 and is again spread out in a layer. A scraper 17 keeps the roll clean during its rotation.

In figure 3 the wiper roll 3 has laid out a thin, even powder layer above the earlier layer 7. Excess powder falls down on an underlying collecting reservoir 13.

In figure 4 the wiper roll 3 goes back to its start position and at the same time the masking device 9 with the IR-producer 8 moves over a developer 1 1, which in the shown embodiment is a writer head. That deposits a masking layer of for instance aluminia

powder in accordance with information received from a not closer shown computer's CAD-unit on the masking device, which can be a glass plate.

Figure 5 shows the meltingphase, during which a shielding device 15, for instance in the form of a Venetian blind, is open and allows the IR-radiation from the ignited IR-lamps to pass. The IR-beams are directed -made parallell- with a collimator 16 and thereafter pass those parts of the glass plate which are not covered by the masking pattern 18. Thereby the exposed parts of the powder layer 7 are melted to an interconnected structure 19.

Figure 6 shows a finished threedimensional body 19 after a lot of repeated applying-sequences before the surrounding loose particle shaped material has been removed.

In the embodiment shown in figures 7 and 8 the powder reservoir 1 or the powder magazine is arranged obliquely above the building reservoir 5 and is in the shown embodiment a transport package, which rest on one of its borders, in which corner part an outlet port is arranged. The inclined V-base of the package lead to that the content without extra meassures is emptied out. In connection with the outlet port is arranged a dosing device 20, which in active position delivers powder to one below that located spreading device 3. This is in this embodiment a wiper tray, which is horisontally displaceable over the building reservoir 5. The wiper tray 3 is on one of its side connected with the glass plate on the masking device 9 and on its opposite side possibly connected with a compression plate 21.

Figure 7 shows a start position, in which the wiper tray 3 is in a position for fetching a certain amount of powder, which during the tray's displacement movement to the oppo-

site end of the building reservoir 5 is applied in an even layer. During this movement the glass plate 9 passes the developer 11, which for instance through electrostatical electrification projects a masking pattern on the glass plate in form of a negative picture of that surface section through the threedimensional body which should be manufactured

When the wiper tray is in its other end position the compression plate will be located right over the newly laid out powder layer 7. In this position the powder layer is moved upwards against the compression plate 2 1, whereby an even layer of uniform thickness is obtained. In this position the tray can emit possible excess powder to the eliminator 10. When the wiper tray is back in its start position the glass plate 9 is in exact position over the buildingreservoir 5 and the meltingphase kan start. The IR-lamps 14 can in this embodiment be secured right opposite and above the building reservoir 5.

LIST OF REFERENCE NUMBER

1	Powder reservoir
2	Moveable base of the powder reservoir
3	spreading device / wiper roll / wiper tray
4	Powder
5	Building reservoir
6	Moveable base of the building reservoir
7	Powder layer
8	IR-radiation producer
9	Masking device / glass plate
10	Eliminator, e.g. a clearing device
11	Developer 11, e.g. computer controlled write head
12	Collecting reservoir for masking powder
13	Collecting reservoir for excess powder
14	IR-lamps
15	Shielding device
16	Collimator
17	Scraper
18	Masking pattern
19	Interconnected structure
20	Dosing device
21	Compression plate
22	Outlet opening of the powder reservoir
23	Side walls
24	Outlet opening of the wiper tray
25	Guiding plates

PATENT CLAIMS

1. A method for producing threedimensional bodies of a large number of mutually connected layers of a particle shaped building material, such as a powder, and where the information of the appearance of each layer is achieved from a cumputer's CAD-unit or similar,
characterized in
that an essentially even particle layer (7) of building material is applied on a support base (6),
that on a masking device (9) is arranged a masking pattern in accordance with the information from the CAD-unit, which masking device is led over said particle layer and close to it,
that a radiation producer (8) is arranged or is led over the masking device (9), whereby the particles which are not covered by the masking pattern are exposed for radiation and thereby are attached to each other,
that the masking pattern is removed from the masking device, and that new sequences in accordance with the above are carried through until the threedimenional body (1 9) is produced.

2. A method according to claim 1,
characterized in
that the particle layer (7) is applied with the aid of a spreading device (3), e.g. a wiper roll, which transfers the particles from a reservoir (1) and spread them over the support base (6).

3. A method according to claim 1,
characterized in
that during movement of the masking device (9) from a parking position beside the support base (6) to an active position over the support base the masking device passes one to the CAD-unit

connected computer controlled developer (1 1), which produces an electrostatical pattern of the layer in question in the form of a layer of masking powder on the support base.

4. A method according to claim 1,

characterized in

that one to the CAD-unit connected computer controlled developer (1 1) is moved over the support base (6), whereby an electrostatical pattern of the layer in question in the form of a layer of masking powder is produced.

5. A device for producing threedimensional bodies of a large number of mutually connectable layers of a particle shaped building material, e.g. a powder, and where the information about each layer's appearance is achieved from an original, for instance from a computer's CAD-unit or similar,

characterized in

that a spreading device (3) is arranged to distribute an essentially even particle layer (7) on a support base (6),

that a developer (1 1) is arranged to generate or apply a masking pattern in accordance with the original, e.g. information from the CAD-unit, on a masking device,

that a radiation producer (8) is adaptable or adapted over the masking device (9),

whereby the particles which are not covered by the maskingpattem are exposed for radiation and thereby are connected to each other, and

that an eliminator (1 0) is arranged to remove the existing masking pattern on the masking device (9).

6. A device according to claim 5,

characterized in

that the spreading device (3) includes a wiper roll, a wiper tray or similar, which is arranged to transport the particles from a powder reservoir (1) and spread the particles in an even layer all over the support base (6).

7. A device in accordance with claim 5,

characterized in

that the powder reservoir (1) is a transport package or similar, which at least during the feeding out of the powder is arranged over the support base (6), that in the bottom of the package is arranged an outlet opening (22) and in connection to that a dosing device (20) for the powder, and that the spreading device (3) and/or the support base are moveable in relation to each other.

8. A device in accordance with claim 5,

characterized in

that the spreading device (3) is one over the support base (6) and the powder layer (7) respectively moveable powder reservoir, which is arranged to meter and spread out via at least one outlet opening (24) a new powder layer in at least one direction of motion.

9. A device in accordance with claim 8,

characterized in

that the inside of the wiper tray (3) and the transport package has inwards inclined side walls (23) and

that guiding plates (25) at the outlet opening (24) of the wiper tray are arranged in the direction of motion of the tray, which guiding plates is arranged to make an acute angle against the support base (6) for compression of the powder layer in connection with or after the spreading.

10. A device in accordance with claim 5,

characterized in

that the powder layer (7) and a compression plate (21) are arranged moveable in relation to each other and arranged to be pressed in contact with one another.

11. A device in accordance with claim 10,

characterized in

that the compression plate (22) is arranged as a cooling member for cooling the powder layer (7).

12. A device in accordance with claim 5,

characterized in

that the spreading device (3) is one over the powder layer (7) moveable, rotateable powder roll, whose rotation of speed and direction of motion are adjustable.

13. A device in accordance with claim 6,

characterized in

that the powder reservoir (1) is provided with an up and down moveable base (2), which when producing each layer is arranged to lift up the powder mass (4) in the powder reservoir corresponding to the thickness or the volume of a layer, and that the support base (6) is an up and down moveable bottom of a building reservoir (5), which when producing each layer is arranged to lower the bottom (4) in the building reservoir corresponding to the thickness or the volume of a layer.

14. A device in accordance with claim 13,

characterized in

that the walls of the building reservoir (5) is made of melted/sintered powder, layer by layer, in the same way as the threedimensional body (19), that the walls are fastened to the moveable base plate (6), and that the walls of the building reservoir (5) are generated by a fix or by the masking device controlled, for the IR-radiation transparent pattern.

15. A device in accordance with claim 13,

characterized in

that the upper circumference of the building reservoir (5) defines a surface which is larger than the underlying opening , which is tightening border for the reservoir (5) built in layers.

16. A device in accordance with claim 5,

characterized in

that the radiation producer (8) comprises a collimator (1 6), which is made of lamellas preferably in at least two different crossing planes above each other, alematively in combination with a spreading device (1 5).

17. A device in accordance with claim 5,

characterized in

that the powder is preheated to a temperature which is lower than the sintering/melting temperature.

18. A device in accordance with claim 17,

characterized in

that the powder is preheated with the aid of infrared radiation member (14) with lower intensity than during sintering and/or by means of that the masking layer (1 8) is partly transparent.

19. A device in accordance with claim 5,

characterized in

that the masking device (9) comprises a writer unit, a developer, and a flowing crystal display or similar for production of the desired masking pattern.

20. A device in accordance with claim 5,

characterized in

that the masking device (9) is a disconnectable and connectable mirror, which is arranged to take at the same time two different states, one in which the mirror is reflecting and

another in which it is transparent, and that said states is controllable with information from a CAD-unit in correspondence to a desired masking pattern.

21. A building material in accordance with claim 5,

characterized in

that the building material during sintering/melting/hardening is arranged to expand (for instance by the aid of an expanding agent which sets free a gas) and thereby compensates the resulting threedimensional body (1 9) for thermal or chemical shrinking.

22. A building material in accordance with claim 5, characterized in

that the material is built around a particle, fiber or ball-shaped core with higher melt temperature than its surface, which is covered with a thin melt- or hardenable layer.

23. A building material in accordance with claim 22, characterized in

that the cores of the material in the threedimensional body can be sintered together in an aftertreatment.

24. A building material in accordance with claim 5, characterized in

that the material consists of a fine-grained powder with a high melt temperature and degree of reflection, e.g. a metal oxide.

25. A device in accordance with claim 5,

characterized in

that the developer (1 1) is arranged to cooperate with a transparent plate (9), on which a layer of masking powder is applied electrostatically.

26. A device in accordance with claim 5,

characterized in

that the developer (1 1) comprises one in or on a transparent plate (9) arranged electrode matrix with a large number of preferably annular-shaped control electrodes, which electrode matrix on one side is provided with a background electrode and which opposite side is turned towards a dosing device for masking material, and that the potentials applied on the control electrodes are variable in accordance with information from the computer's CAD-unit.

27. A device in accordance with claim 5,

characterized in

that the eliminator (3) is a cleaning device, which is arranged to clean the transparent layer from the masking material forming the masking layer, whereby possible excess material preferably can be returned to the masking device.

28. A device in accordance with claim 27,

characterized in

that the eliminator (3) is arranged to change the state of voltage in the display so that the masking pattern is erased.

29. A building material in accordance with claim 1 or 5,

characterized in

that the material consists of a grain-shaped melt- and/or sinterable material, for instance a thermoplastic, such as nylon, provided with a carbon based pigment powder with high absorption within the IR-range.

30. A building material in accordance with claim 29,

characterized in

that the material has a large proportion of polar OH-groups or double bonds in the molecular chaines.

3 1. A building material in accordance with claim 29,

characterized in

that the building material is an epoxide plastic, which contains a heat reactive hardener, e.g. amine, which after sintering and/or melting cross-binds the chains of the plastic molecules.

32. A building material according to claim 29,

characterized in

that the material is mixed with reinforcing material, for instance a metal, ceramic or mineral in form of fibers, balls or particles.

33. A building material in accordance with claim 29,

characterized in

that after melting and/or sintering of the reinforcing material the plastic material is removed through combustion, soaking or similar.

34. A masking material in accordance with claim 1 or 5,

characterized in

that the masking material consists of oxide of aluminia with high melttemperature and degree of reflection.

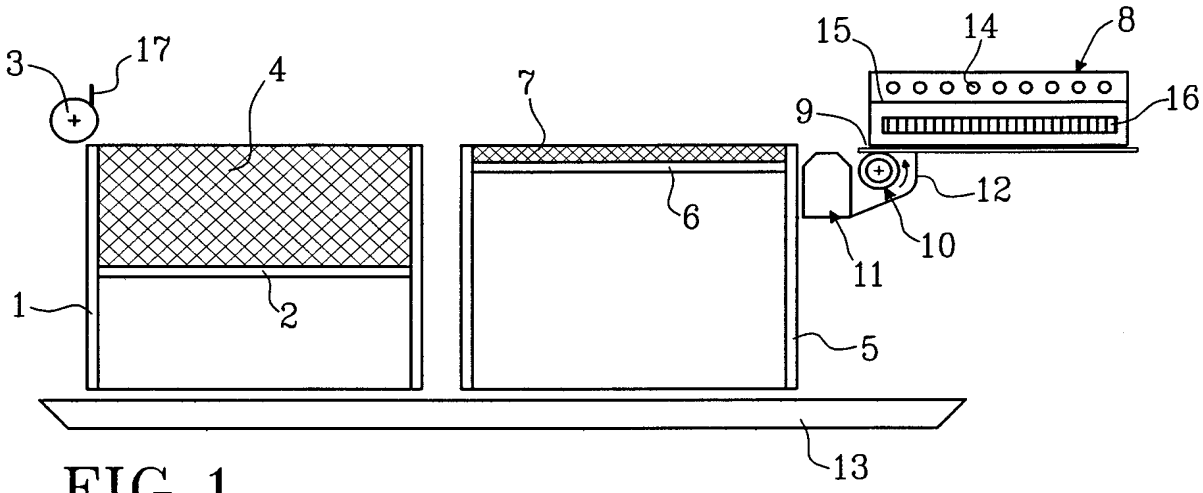

FIG.1

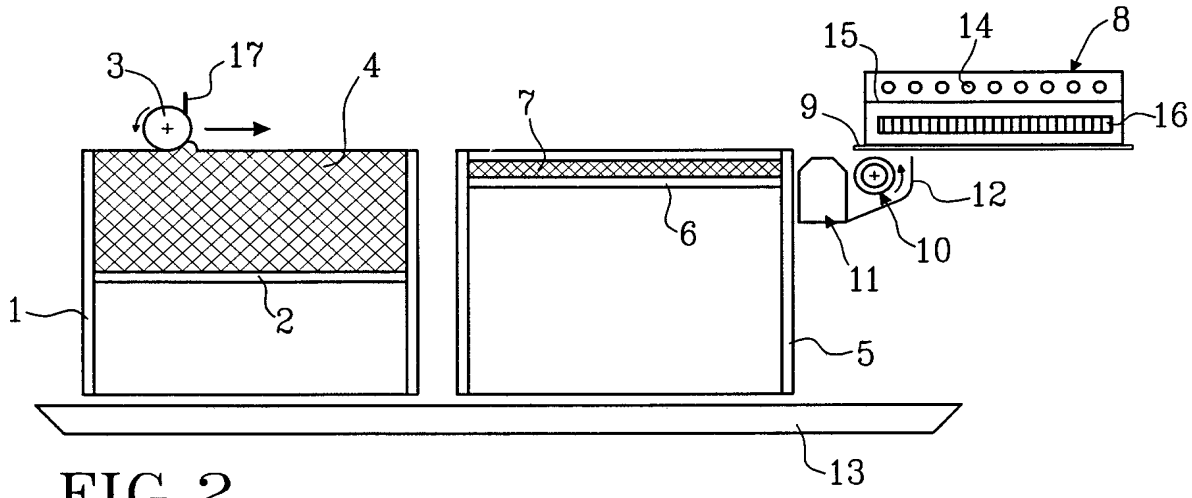

FIG.2

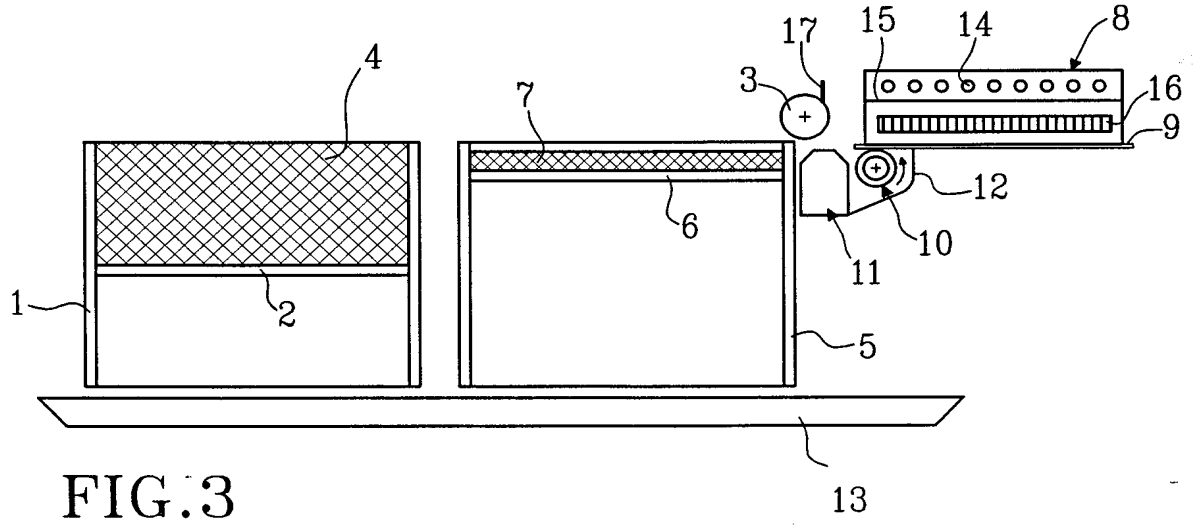

FIG.3

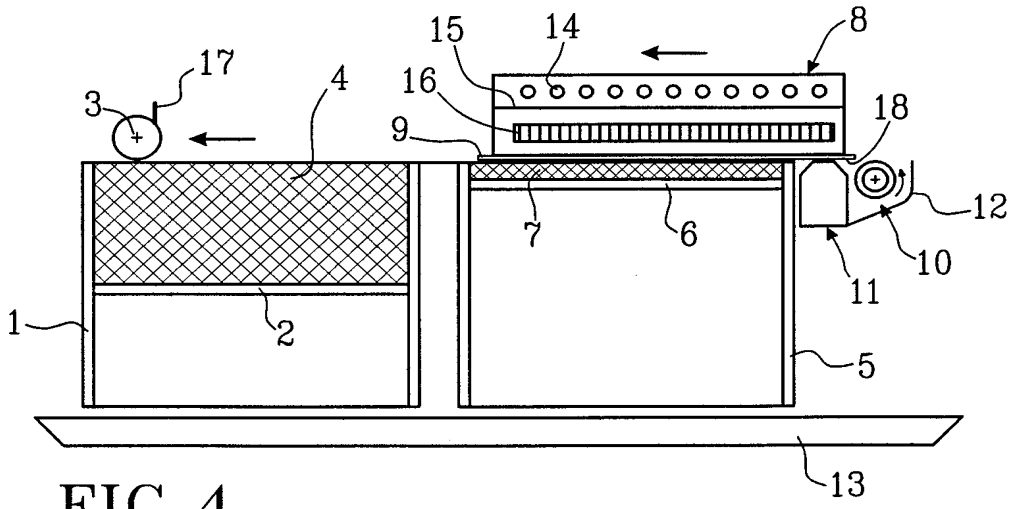

FIG.4

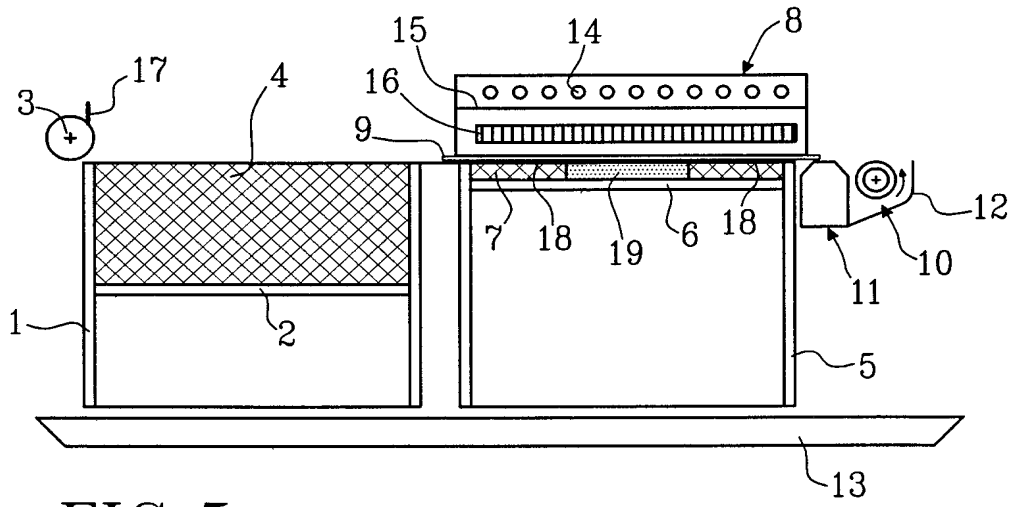

FIG.5

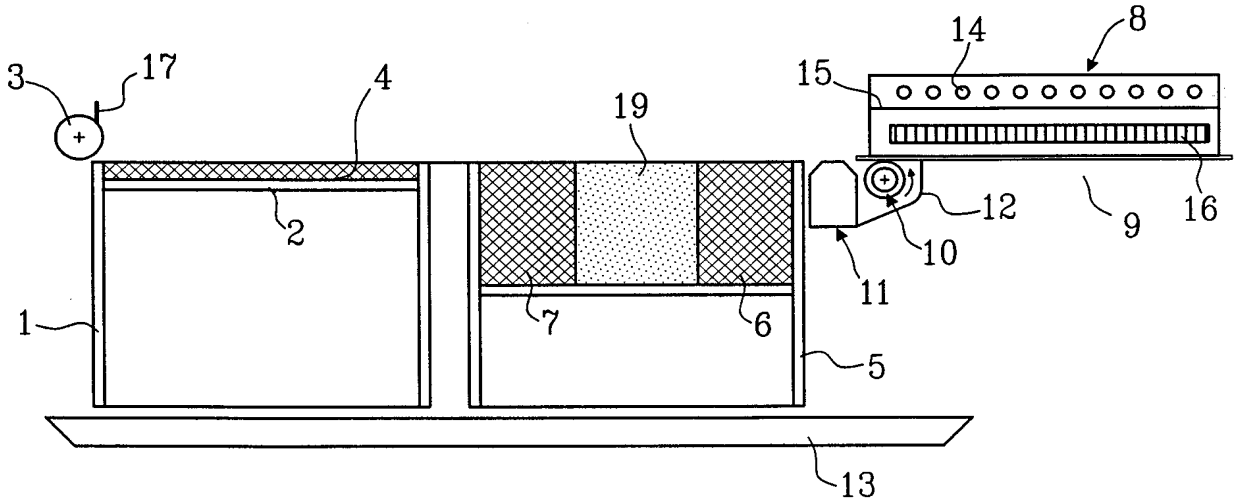

FIG.6

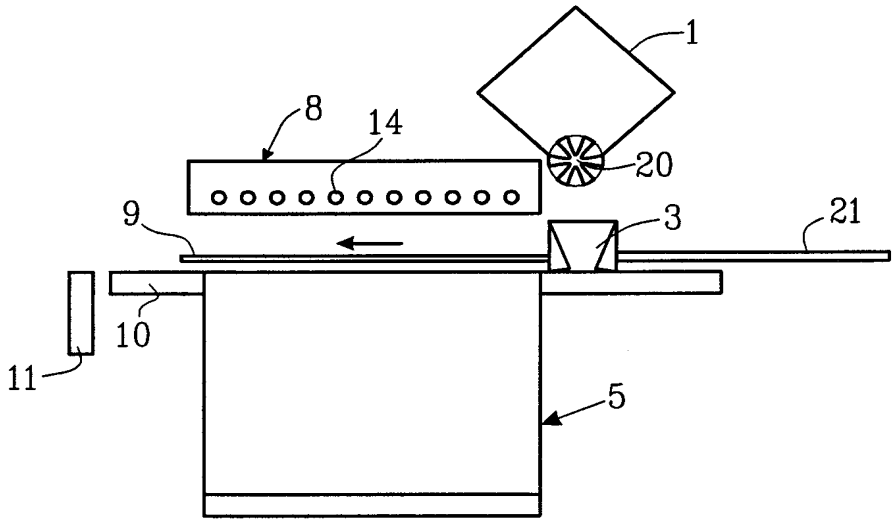

FIG.7

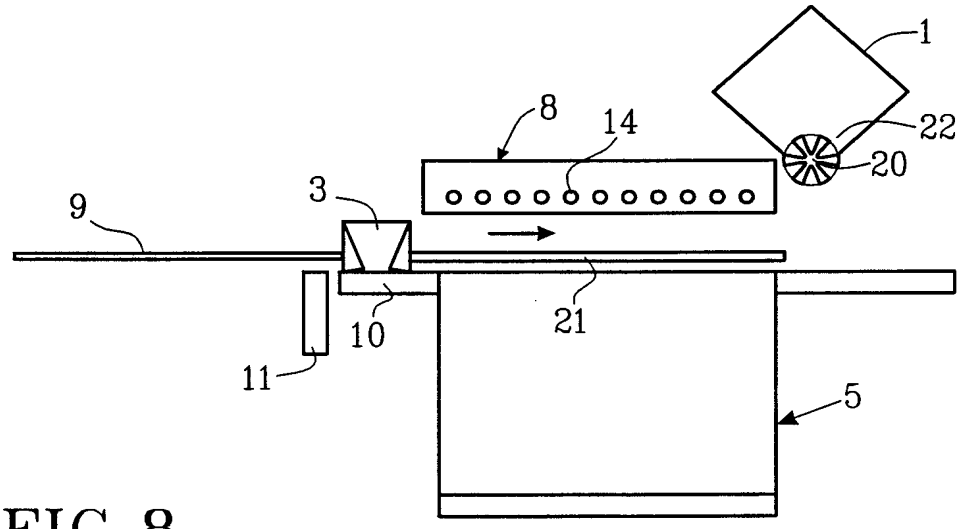

FIG.8

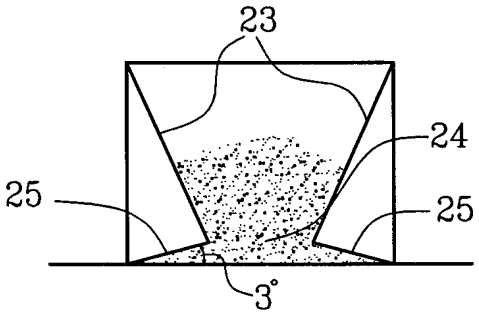

FIG.9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00808

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B29C 39/42
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5512122 A (HAROLD W. SOKYRKA), 30 April 1996 (30.04.96), abstract ---	1-34
A	FR 2567668 A1 (COMPAGNIE INDUSTRIELLE DES LASERS CILAS ALCATEL), 17 January 1986 (17.01.86), abstract ---	1-34
A	US 5387380 A (MICHAEL CIMA ET AL), 7 February 1995 (07.02.95), abstract ---	1-34
A	EP 0470705 A2 (CUBITAL LTD.), 12 February 1992 (12.02.92), abstract --- --------	1-34

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 1998	29 -07- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Tommy Vikholm Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/06/98

International application No.
PCT/SE 98/00808

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5512122 A	30/04/96	CA 2053675 A	18/04/93
		AU 5173593 A	09/05/94
		CA 2126104 A	28/04/94
		EP 0617723 A	05/10/94
		WO 9409078 A	28/04/94
FR 2567668 A1	17/01/86	NONE	
US 5387380 A	07/02/95	CA 2136748 A	23/12/93
		EP 0644809 A	29/03/95
		JP 7507508 T	24/08/95
		WO 9325336 A	23/12/93
		CA 2031562 A,C	09/06/91
		DE 69025147 D,T	05/09/96
		EP 0431924 A,B	12/06/91
		SE 0431924 T3	
		JP 2729110 B	18/03/98
		JP 6218712 A	09/08/94
		US 5204055 A	20/04/93
		US 5340656 A	23/08/94
EP 0470705 A2	12/02/92	NONE	